

## MEMORANDUM

**To: EAAC**  
**From: James K. Boyce**  
**Re: Investment in Disadvantaged Communities**  
**Date: October 5, 2009**

This memorandum discusses issues related to investment in disadvantaged communities, including localities that are disproportionately impacted by co-pollutants associated with use of fossil fuels.<sup>1</sup>

### AB 32 provisions

Section 38565 of the California Global Warming Solutions Act of 2006 (AB32) mandates that CARB should seek to channel investment to the state's most disadvantaged communities:

*The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions.*

In addition, section 38570(b) mandates that the California Air Resources Board (CARB) should consider localized impacts of co-pollutants:

*Prior to the inclusion of any market-based compliance mechanism in the regulations, to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the state board shall to all of the following: (1) Consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution. (2) Design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants.*

As documented below, disadvantaged communities often are disproportionately impacted by air pollutants, including co-pollutants generated by the use of fossil fuels. One way to respond to these mandates is to allocate a share of allowance value to such communities for the purpose of environmental improvements.

This use of allowance value primarily involves investment, but it also can be categorized as "compensation" in that a community's eligibility to receive benefits rests on its

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<sup>1</sup> This is a revised and expanded version of the author's memo on "Co-Pollutants and Co-Benefits," dated August 3, 2009.

disadvantaged status including disproportionate pollution exposure. However, this differs fundamentally from other types of compensation that rest on claims of losses *relative to the status quo ante* prior to AB 32 implementation. The case for compensation to localities rests instead on disadvantages that antedate AB 32. That is, eligibility for compensation does not require that AB 32 causes an increase in co-pollutants in the localities – an outcome specifically prohibited in section 38570(b), quoted above – but rather that disproportionate impacts *relative to other localities* persist after AB 32 implementation. Again unlike other types of compensation, the aim in this instance is not to “make the recipient whole” but rather to mitigate gaps in environmental and economic well-being in disadvantaged localities relative to statewide norms.

### General considerations

Co-pollutants and the co-benefits from their reduction are relevant to the efficiency, environmental, and fairness objectives of AB32.

### *Efficiency considerations*

The efficiency objective implies that policy should seek to maximize net social benefits from reducing greenhouse gas emissions. These benefits include co-pollutant reductions. To ignore them would be tantamount to leaving health-care dollars lying on the ground.

From a climate-change standpoint, the marginal benefit of carbon reductions is constant across emission sources. But in the presence of co-pollutants – such as particulate matter, NO<sub>x</sub>, and air toxics released by the burning of fossil fuels – the marginal benefit can and does vary across emission sources.

As is well-known, variations in marginal abatement costs across pollution sources provide the static-efficiency rationale for using market-based incentives (such as cap-and-trade), as opposed relying exclusively on regulatory standards to achieve pollution-control objectives. The aim is to achieve pollution reductions at least total cost.

Variations in marginal abatement benefits complicate the picture, however. These variations provide a rationale for greater pollution reductions (and higher marginal abatement costs) for some emission sources than for others.

Muller *et al.* (2009) estimate that on average, the co-benefits from co-pollutant reductions due to a nationwide cap on carbon emissions will be on the same order of magnitude as the benefits from carbon emissions reduction itself.<sup>2</sup> In a study of the co-benefits of

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<sup>2</sup> Nicholas Z. Muller, Britt Groosman and Erin O'Neill-Toy, “The ancillary benefits of greenhouse gas abatement in the United States.” Forthcoming, 2009. See [http://college.usc.edu/geography/ESPE/documents/Muller\\_USC\\_6\\_30\\_09.pdf](http://college.usc.edu/geography/ESPE/documents/Muller_USC_6_30_09.pdf).

carbon emission reductions in the European Union, Berk *et al.* (2006) reach similar conclusions.<sup>3</sup>

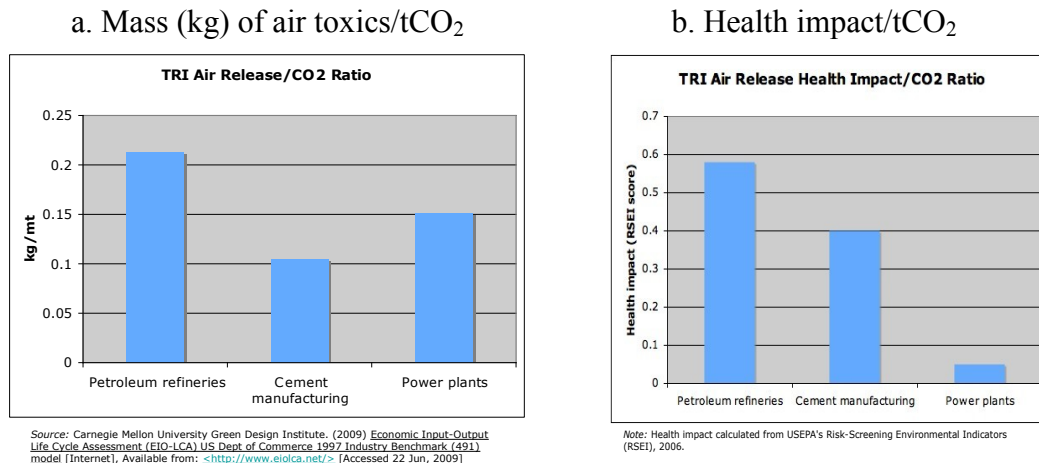
In addition to improvements in the quantity and quality of life, benefits from co-pollutant reductions include health-care cost savings, reductions in days lost from work due to illness and the need to care for ill children and other dependents, and gains in property values.

In economic terms, the co-benefits from co-pollutant reduction add to the benefits from reduced carbon-dioxide emissions. This justifies greater reductions (tighter caps, higher permit prices, and higher marginal abatement costs) than would be warranted in the absence of co-benefits.

If co-pollutant intensity, here defined as the ratio of co-pollutant damages to carbon-dioxide emissions, were a fixed coefficient, there would be no efficiency case for modifying policy design (beyond adjusting the cap) to take co-pollutants into account. But there are strong *a priori* reasons to expect that co-pollutant intensity varies across regions, sectors and polluters. Empirical evidence supports this view.

The ratio of co-pollutant emissions to carbon-dioxide emissions varies depending on the fuel source (higher for coal, lower for natural gas, in-between for oil) and on pollution control technologies. In addition, damages per unit of co-pollutant emissions vary depending, among other things, on stack heights, population densities, and total exposure (the marginal damage function is usually assumed to be convex, with marginal damage increasing in total exposure).

**Figure 1: Intersectoral variations in co-pollutant intensity**  
(air toxics/ton CO<sub>2</sub>)



<sup>3</sup> M.M. Berk *et al.*, "Sustainable energy: Trade-offs and synergies between energy security, competitiveness, and environment." Bilthoven: Netherlands Environmental Assessment Agency (MNP), 2006.

These variations are illustrated in Figure 1, which shows co-pollutant intensity for air toxics releases reported in the USEPA's Toxics Release Inventory (TRI) from three industrial sectors: petroleum refineries, cement manufacturing, and power plants. Panel (a) shows total mass of releases (kilograms) of the roughly 600 chemicals in the TRI database per ton of carbon-dioxide emissions. By this measure, petroleum refineries have roughly twice the co-pollutant intensity of cement manufacturing facilities, with power plants lying between the two. Panel (b) shows the relative human health impacts of these same releases, taking into account stack heights, toxicities, the fate-and-transport of chemicals in the environment, and population densities. Petroleum refineries again score highest by this measure, but power plants score below cement manufacturing.

From the standpoint of efficiency, the existence of co-pollutants therefore implies not only that the cap on carbon emissions should be tighter than what would be warranted by the environmental impacts of carbon-dioxide alone, but also that policy design should respond to variations in co-pollution intensity.

#### *Environmental considerations*

The environmental objective refers to the full range of pollution-reduction benefits that AB 32 implementation can bring about.

Air pollution is generated by a variety of sources, not all of them related to fossil fuels. Examples of other sources include solvent evaporation, waste disposal, and (in the case of particulate matter) windblown dust. The production and use of fossil fuels account for a substantial share of emissions of many important pollutants.

**Table 1: Percentage share of California emissions derived from production and use of fossil fuels**

<i>Pollutants:</i>	ROG	CO	NOX	SOX	PM2.5
<i>Sources:</i>					
Fuel combustion (stationary & residential)	3.8	7.2	10.4	2.9	20.8
Mobile sources	51.2	79.8	85.5	58.9	19.7
Petroleum production & marketing	6.1	0.1	0.3	14.1	0.5
<b>Total</b>	<b>61.1</b>	<b>87.1</b>	<b>96.2</b>	<b>73.0</b>	<b>41.0</b>

*Key:* ROG = reactive organic gases  
CO = carbon monoxide  
NOX = nitrogen oxides

SOX = sulfur oxides  
PM2.5 = fine particular matter

*Source:* CARB, "Almanac Emission Projection Data (Published in 2009)," online at [http://www.arb.ca.gov/app/emsinv/emssumcat\\_query.php?F\\_YR=2008&F\\_DIV=-4&F\\_SEASON=A&SP=2009&F\\_AREA=CA](http://www.arb.ca.gov/app/emsinv/emssumcat_query.php?F_YR=2008&F_DIV=-4&F_SEASON=A&SP=2009&F_AREA=CA)

Table 1 presents data on fossil-fuel related emissions of reactive organic gases and four criteria air pollutants as a share of total statewide emissions. The contribution of fossil fuels ranges from 41% in the case of fine particulate matter to 96% in the case of nitrogen oxides. The transportation sector (mobile sources) accounts for the major share with the exception of fine particulate matter, where stationary and residential sources contribute slightly more to the total.

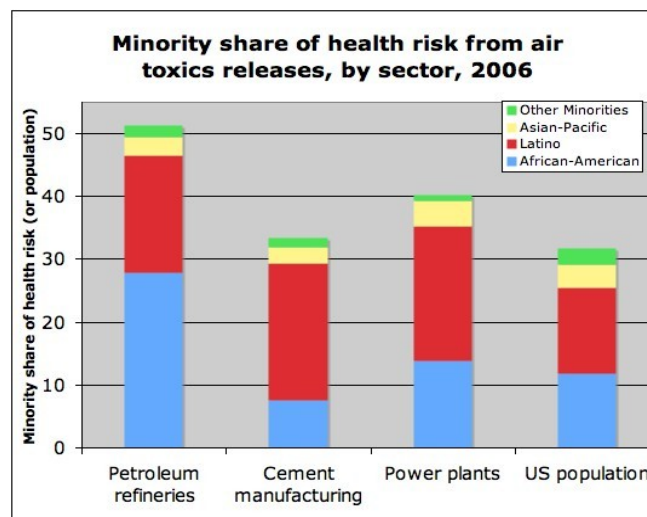
If, as is commonly assumed, air pollution damages are convex in total exposure – that is, marginal damage per ton of pollution exceeds average damage per ton – then the environmental significance of reductions in co-pollutants as a co-benefit of carbon policy may be even larger than the numbers in the table suggest.

### *Fairness considerations*

The fairness objective implies that policy should seek to reduce disproportionate pollution in historically overburdened communities. For this reason the issue of co-pollutants has been emphasized by the Environmental Justice Advisory Committee (EJAC).

If co-pollutants were uniformly (or randomly) distributed across the landscape, there would be no fairness reason to design policy to take them into account. But again, both *a priori* reasoning and empirical evidence tell us that they are not uniformly distributed, and that some communities – often lower-income communities – are overburdened by co-pollutants. Figure 2 illustrates this point, showing health risks from air toxics for the same three industrial sectors, relative to the shares of demographic subgroups in the national population. Petroleum refineries have the most disproportionate impact.

**Figure 2: Shares of health risk from air toxics**



Source: Minority shares of health impact calculated from RSEI-GM data; for methodology, see Ash et al., *Justice in the Air: Tracking Toxic Pollution from America's Industries and Companies to our States, Cities and Neighborhoods*, PERI and PERE, April 2009.

CARB recently resolved “to develop a methodology using available information to assess the potential cumulative air pollution impacts of proposed regulations to implement the Scoping Plan” and “to identify communities already adversely impacted by air pollution as specified in Health and Safety Code section 38750(b)(1) before the adoption of a cap-and-trade program.”<sup>4</sup> The resulting information is expected to influence policy design.

Researchers at the University of Southern California, Occidental College, and the University of California, Berkeley, have initiated work to assist CARB in these tasks, developing a Cumulative Impact score method to screen for disproportionate air pollution impacts based on (i) hazard proximity and sensitive land uses, (ii) health risk, and (iii) social and health vulnerability.<sup>5</sup> Applying this methodology, the researchers have identified the highest-scoring census tracts in the six-county SCAG (Southern California Association of Governments) area. Socio-demographic data show that these tracts have relatively high percentages of Latinos and African-Americans and relatively low incomes (see Table 2).

**Table 2: Socio-Demographic Characteristics (2000) for Tracts with Highest Cumulative Impact Score, 6-County SCAG Area**

	Top 6.2% of tracts	Top 12.9% of tracts	Top 20.1% of tracts	SCAG area totals
Total population	924,584	2,035,173	3,270,659	16,479,143
% population	5.6%	12.3%	19.8%	100.0%
% nonwhite	95.4%	92.8%	89.9%	61.2%
% below poverty	33.2%	30.2%	27.9%	15.7%
Median household income	\$25,269	\$27,533	\$29,686	\$50,165
Per capita income	\$9,221	\$10,097	\$10,880	\$21,101
% black	7.7%	9.2%	10.4%	7.3%
% Hispanic	79.0%	74.5%	69.9%	40.6%
% Asian	7.4%	7.7%	7.8%	10.4%
% other race	1.2%	1.5%	1.8%	2.8%

*Source:* Unpublished data furnished upon request by Dr. Manuel Pastor, University of Southern California, Program for Environmental & Regional Equity.

<sup>4</sup> CARB, “Climate Change Scoping Plan, Resolution 08-47,” December 11, 2009, p. 8. See also Manuel Pastor, Rachel Morello-Frosch and Jim Sadd, “Environmental Justice Screening Method: Integrating Indicators of Cumulative Impact and Community Vulnerability into Regulatory Decision-making,” presented at CARB Informational Board Workshop on Policy Tools for the AB 32 Scoping Plan, May 28, 2008, online at [http://www.arb.ca.gov/cc/scopingplan/meetings/5\\_28notice/presentations/pastor\\_5\\_28.pdf](http://www.arb.ca.gov/cc/scopingplan/meetings/5_28notice/presentations/pastor_5_28.pdf).

<sup>5</sup> For details, see Manuel Pastor, Jim Sadd and Rachel Morello-Frosch, “Air Quality, Environmental Justice, and Social Vulnerability,” presented at the South Coast Air Quality Management District Conference on New Perspectives on Community Health and Air Quality, July 24, 2009. Online at [http://www.aqmd.gov/pubinfo/events/communityhealthairqualityconf/PDF/Pastor\\_AQMDJuly2009.pdf](http://www.aqmd.gov/pubinfo/events/communityhealthairqualityconf/PDF/Pastor_AQMDJuly2009.pdf).

## Policy Options

The remainder of this memorandum sketches three policies that could be implemented in order to advance the efficiency, environmental, and fairness objectives of AB 32 in relation to co-pollutants: (i) investment by allocating allowance value to a community benefits fund; (ii) a co-pollutant surcharge; and (iii) zonal trading systems.

### *(i) Investment: Community benefits fund*

One way to tackle co-pollutant issues in AB 32 implementation is to allocate some fraction of the revenue from permit auctions to overburdened communities, with the money to be used for compensating environmental improvements.

Compensation is widely invoked to justify allocations of allowance value (whether free permits or revenue from permit auctions). Allocations to trade-exposed firms are proposed as a way to compensate them for the impacts of carbon policy on their competitiveness. Allocations to the electric utility industry are proposed as a way to compensate them for the costs of investment in clean energy infrastructure. Allocations to consumers often are rationalized as a way to counteract the effect of higher fossil fuel prices on their real incomes (in the case of cap-and-dividend, an additional rationale is sometimes advanced, namely that the new property rights created by carbon permits rightly belong in common and in equal measure to all). Similarly, the allocation of auction revenue to overburdened communities can be viewed as a way not only to invest but also to compensate for excess co-pollutant burdens.

Issues in developing and implementing a community benefits fund (CBF) policy include:

- how much revenue (or more precisely, the percentage of allowance value) to allocate to CBF;
- which communities are eligible to receive funds;
- what sorts of environmental projects are eligible; and
- what mechanisms should be established to allocate funds across and within communities.

California Assembly Bill 1405, currently being considered in the state legislature, contains specific proposals on these issues. The bill would require that a minimum of 30% of the revenues generated under AB 32 be deposited into the CBF. The bill defines “the most impacted and disadvantaged communities as those areas within each air basin with the highest 10 percent of air pollution impacts, taking into account air pollution exposures and socioeconomic indicators.” Within these communities, the CBF would provide competitive grants for projects for purposes such as reducing emissions of greenhouse gases and co-pollutants, minimizing health impacts caused by global

warming, and emergency preparedness for extreme weather events caused by global warming.<sup>6</sup>

The language in AB 1405 provides a reasonable basis for EAAC and CARB to envision how a CBF component might work. In thinking through this prong of a strategy to incorporate co-benefits in policy design, the main issue for EAAC is the appropriate percentage of allowance value to be allocated to this use. For example, a “10-10” formula might allocate 10% of total allowance value to localities with the highest 10% of air pollution impacts.

*(ii) Co-pollutant surcharge*

A second way to incorporate co-pollutants into AB 32 implementation policy is to levy a surcharge on carbon permits in overburdened jurisdictions, and to dedicate the surcharge revenue to community benefits funds in the same jurisdictions where it is collected.

Attractive features of this option include the following:

- The use of surcharge revenue for this purpose would reduce the need to allocate revenues from carbon permit auctions to CBFs.
- There would be a tight nexus between the fee (surcharge) and its use.
- The surcharge would promote greater emission reductions in places where abatement benefits are greater due to high co-pollutant burdens.
- It affirms the principle that the “sink” functions of air (as a medium for disposal of wastes) belong to the people who breathe it.

To implement such a system, CARB would again identify overburdened locations where the co-pollutant surcharge would be levied, at the time of carbon permit surrender in the case of stationary sources or and the time of fuel delivery in the case of residential and mobile sources. By increasing the price of fossil fuels above what it would be in the absence of the surcharge, this would provide an incentive for greater emissions reductions in these locations. The revenue from the surcharge would then be allocated to CBFs in the same locations.

*(iii) Zonal trading systems*

A third way to include co-benefits from co-pollutant reductions in cap-and-trade policy design is to establish “zones” to guarantee some minimum level of emissions reductions in high-priority locations where co-benefits are greatest. Such areas may be identified using the methodology currently being developed by CARB.

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<sup>6</sup> As of this writing, versions of AB 1405 have been passed by the Assembly and two Senate committees. The text is available at [http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab\\_1401-1450/ab\\_1405\\_bill\\_20090723\\_amended\\_sen\\_v94.pdf](http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_1401-1450/ab_1405_bill_20090723_amended_sen_v94.pdf).



In zonal trading systems, the availability of permits is defined on a zone-by-zone basis, i.e., permits are allocated across zones within the overall cap. Zone-based “sub-caps” can be established regardless of whether permits are distributed via auction, free allowances, or some combination of the two. The zones create semi-permeable boundaries for permit trading: polluters in lower-priority zones can buy permits from polluters in higher-priority zones, but permit trades against this gradient are not allowed.

Similarly, the purchase of offsets is constrained or proscribed altogether in high-priority zones. In the presence of co-pollutants, the purchase of offsets from out-of-state has the effect of exporting the co-benefits from air quality improvements.<sup>7</sup> In the same way, offsets would result in the loss of co-benefits from co-pollutant reduction in high-priority zones.

A zonal system need not be restricted to point-source emissions: it could be applied to mobile sources as well. Just as AB 32 effectively makes the state of California into a “zone” where carbon emissions from both point sources and mobile sources can be capped differentially from other states, so a zonal system can differentiate across regions and/or localities within the state.

One precedent for a zonal trading system is California’s Regional Clean Air Incentives Market (RECLAIM), launched in 1994 to reduce point-source emissions of nitrogen oxides and sulfur oxides in the Los Angeles basin. The South Coast Air Quality Management District established two zones under RECLAIM: zone 1, the coastal zone, where pollution is more severe and the benefits from pollution reduction are considered to be greater; and zone 2, the inland zone, where pollution is less severe. Facilities in zone 1 can buy permits only from other facilities in the same zone; facilities in zone 2 can buy permits from either zone. One impact of the RECLAIM zonal trading system is that average permit prices have been roughly eight times higher in zone 1 than in zone 2.<sup>8</sup>

In the absence of regionally variable co-pollutant intensity, these permit price differentials across zones would be a symptom of inefficiency. If marginal abatement benefits were equal across pollution sources, the efficiency criterion would call for equalization of marginal abatement costs as well. But as noted above, co-pollutants result in variations in marginal abatement benefits, and for this reason, permit price differentials can be an efficiency-improving result.

A zonal trading system – whether comprising two zones as in RECLAIM, or several zones – cannot, of course, perfectly match marginal abatement costs to all variations across pollution sources in marginal abatement benefits. Within any zone, some variations will persist. But the question is not whether a zonal trading system yields

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<sup>7</sup> David Roland-Holst, “Carbon Emission Offsets and Criteria Pollutants: A California Assessment,” University of California Berkeley, Center for Energy, Resources, and Economic Sustainability, Research Paper No. 0903091, March 2009.

<sup>8</sup> Lata Gangadharan, “Analysis of prices in tradable emission markets: An empirical study of the Regional Clean Air Incentives Market in Los Angeles,” *Applied Economics* 36: 1569-1582, 2004.

textbook efficiency; it is whether it yields a better outcome in terms of environmental, efficiency, and equity criteria than a system without zones. When externalities are spatially differentiated – that is, when emission location matters – zonal trading systems can be a “second-best” solution that yields a better outcome than the no-zone alternative.<sup>9</sup>

### Concluding remarks

Policies to reduce carbon-dioxide emissions from burning fossil fuels generate co-benefits – above and beyond the climate-change benefits – by reducing emissions of co-pollutants that harm human health. Valuation studies suggest that these co-benefits are comparable in magnitude to the benefits of carbon-dioxide emission reductions alone.

Damages from co-pollutants per unit carbon-dioxide emissions vary across locations and pollution sources. Historically overburdened communities tend to be economically and socially disadvantaged in other respects as well.

Hence the efficiency, environmental, and fairness objectives of AB 32 can be furthered by policies that take co-pollutants and co-benefits into account.

This memorandum has sketched three policy options:

- (i) allocating some fraction of allowance value to community benefits funds (CBFs);
- (ii) introducing a co-pollutant surcharge, with the proceeds dedicated to CBFs; and
- (iii) establishing a zonal trading system that restricts the ability of polluters in high-priority localities from “buying out” of emission-reduction obligations by purchasing offsets or permits from other localities.

These three options are not mutually exclusive. Rather they can be regarded as complementary instruments to advance the same goal: incorporating co-pollutants and the co-benefits from their reduction into climate policy design.

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<sup>9</sup> Tom Tietenberg, “Tradeable permits for pollution control when emission location matters: What have we learned?” *Environmental and Resource Economics* 5: 95-113, 1995.